Project Proposal to

M. NIGHT SHYAMALAN FOUNDATION

Mountain Rain: El Ñajo

Rainwater harvesting, sanitation and improvements to access in the hillside community of El Ñajo, Telica, Nicaragua

October 2011
Executive Summary

‘Mountain Rain’ is a long-term integrated programme which aims to encourage the development of sustainable livelihoods in seven hillside communities in an environmentally sensitive and disaster vulnerable area of western Nicaragua. One of the fundamental challenges for these communities is access to water. With the nearest source more than 5 km away for some, these families face a daily four hour journey on foot or horseback to collect water to meet only the most basic needs, consuming time and energy to the detriment of farming and education. Environmental degradation of the hillsides where these families live has resulted in mass deforestation through tree felling and slash and burn farming. This in turn has caused soil erosion, increasing vulnerability to natural disasters.

Under the Mountain Rain programme, Nuevas Esperanzas is helping farmers construct rainwater harvesting systems and protect springs. Access to the communities is being improved, both to facilitate construction and to give farmers better access to their land to take their produce to market. Sustainable forms of generating income are being introduced to use the natural resources of the land without continuing to degrade the environment. This programme is underpinned by a strong emphasis on community development, leadership, organisation and education.

The present proposal is focused on the smallest of the seven communities, El Ñajo. located on the north-eastern slopes of Volcán Telica, between 300 and 450 metres above sea level, within the Telica-Rota Protected Area and around 4 km from the active crater of the volcano. Of the seven communities in the Mountain Rain programme, El Ñajo is considered to be the best prepared for the next significant investment of resources. The community participated well in the construction of a communal rainwater harvesting system in 2009 and women and men from El Ñajo have participated enthusiastically in the family gardens and beekeeping project respectively. The principal objectives of this project are to improve access to the community of El Ñajo, to increase the availability of water and to provide basic sanitation.

For the first time, access to the community will be possible in all seasons by vehicle and ox and cart through the construction of a 3 km partially-paved road. Gabions will be built to prevent erosion and steep sections of the road paved with cemented cobbles. This intensive work will require consistent and committed community participation over a period of three months. Experience from other communities has shown that access by road gives remote communities a much-valued lifeline and that most people who live in the hillsides are prepared to dedicate considerable effort to achieve this goal.

Access to water will be improved through the construction of two 20 m³ and two 30 m³ rainwater harvesting tanks. Rainwater harvesting provides a sustainable, environmentally friendly, relatively simple and cost effective way of providing water of excellent quality for the whole of the dry season. Four families will directly benefit from this water, whilst two further families will benefit by a reduction in the demand on the existing communal rainwater harvesting tank. By the end of the project, all families in El Ñajo will have a source of water within 50 m of their houses. Every family will have access to sanitation through the construction of seven ventilated pit latrines.

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“Nuevas Esperanzas” (Spanish for “New Hope”) was established in November 2005 in Nicaragua as a programme to assist poor communities through projects which provide practical and technical assistance in support of long-term sustainable development. Nuevas Esperanzas works in a number of sectors including agriculture, water, the environment, health and housing and aims to integrate innovation and technical excellence with good practice in development, always mindful of the complex web of economic, environmental, social and spiritual issues which conspire against those living in poverty.

The programme was first set up to continue projects previously initiated by Mercy Ships, an international aid organisation, which closed its operations in Nicaragua in October 2005 after eight years working in the country. “Programa Nuevas Esperanzas” was initially established as an autonomous programme of a local non-governmental organisation, FUNDAPADELE (Fundación para el Desarrollo de León).

Nuevas Esperanzas UK was formed by a Declaration of Trust signed on 11th August 2006. Charitable status was granted on 12th September 2006. The organisation is governed by the Trust deed which gives the trustees the power to apply the funds for the relief of poverty in Nicaragua. Nuevas Esperanzas UK was registered as an international non-governmental organisation in Nicaragua on 27th October 2006 (Numero Perpetuo 3537) and has a cooperation agreement with Government of Nicaragua, signed on 27th November 2006. All programme activities in Nicaragua are currently undertaken by Nuevas Esperanzas UK.

Nuevas Esperanzas US in Latin America Incorporated’ was registered in Massachusetts in 2009. Nuevas Esperanzas US is a 501(c)(3) registered non-profit organization in the United States. All donations are tax deductible for US taxpayers.

Mission, vision and values

Our mission is to provide practical and technical assistance to communities in Nicaragua as they seek to establish sustainable livelihoods which lift them out of poverty and to encourage transformational development, both material and spiritual, at all levels of society.

Our vision is a just and free society in which we are all able to fulfil our God-given potential, looking to the interests of others as well as ourselves.

Our values include:

Commitment and Vision We recognise that transformational development is a process which requires a long-term commitment and not a quick fix solution. We aim to promote and model a vision for the future and a commitment to see through our work to its conclusion.

Honesty and Transparency We aim to be honest and consistent in what we say, in the way we manage our finances and in our relationships with beneficiaries, donors and the government. We strive to be transparent in our accounting and reporting, and to acknowledge our failures when things go wrong.

Professionalism and Innovation We seek to encourage and develop professional skills within our team and in the communities in which we work. We encourage innovation and aim to apply appropriate technologies in our projects, developing new solutions to old problems where necessary.

Ecumenism and Inclusiveness As followers of Jesus, we believe in the power of the gospel to transform society. We are passionately ecumenical, appreciating the diversity of spiritualities represented in different denominations, both Catholic and protestant, and strive to be inclusive, working without prejudice with people of all faiths and none.

Empowerment and Stewardship We seek to empower our staff and the people with whom we work, giving a voice to the poor and ensuring that decisions are made at the appropriate levels. We promote ownership and responsibility through the application of participatory techniques which encourage communities to find their own solutions to the challenges they face.
Background to the Mountain Rain programme

For many rural communities in Western Nicaragua, access to water is a challenge. The problem is particularly acute for those communities located high up amongst the volcanic hills of the Telica-Rota Protected Area. With the nearest source more than 5 km away for some, these families face a daily four hour journey on foot or horseback to collect water to meet only the most basic needs, consuming time and energy to the detriment of farming and education. Environmental degradation of these catchments over the last fifty years has resulted in mass deforestation through tree felling, slash and burn farming and widespread burning of hillsides to hunt and to harvest honey. This in turn has caused extensive soil erosion, increasing vulnerability to natural disasters such as landslides which have devastated other communities in this hurricane-prone part of Nicaragua. Previous attempts to attenuate environmental degradation have failed for lack of stakeholder participation, whilst families previously relocated in an attempt to reduce their vulnerability have all returned to their ancestral land. Most farmers grow only the most traditional crops, corn and beans, primarily for subsistence, and very few are aware of alternative crops which are more profitable and which could better suit the environmental context in which they live.

Nuevas Esperanzas has been working with communities in the highest parts of the protected area since 2005 and has established a close relationship with many farmers. This has presented the organisation with a unique opportunity to influence attitudes and practices and, in recognition of this opportunity, the Ministry of the Environment invited Nuevas Esperanzas to co-manage the protected area in 2008. Under a long-term and wide-ranging programme called ‘Mountain Rain’, Nuevas Esperanzas has begun to address the most urgent needs in these communities in a structured and integrated way. Nuevas Esperanzas is helping farmers in the Telica-Rota Protected Area construct domestic rainwater harvesting systems as well as protect springs in five dispersed communities. Access to the communities is being improved, both to facilitate construction and to give farmers better access to their land to take their produce to market. Extension workers are helping farmers diversify their farms, introducing more profitable and environmentally sustainable ways of using the natural resources of their land, such as beekeeping, agroforestry and fruit growing. Women are also being encouraged to realise their potential as producers through organic family gardens. Under future work planned, women from the communities will manage improvements to sanitation and promote better hygiene, ensuring that all beneficiaries have access to a latrine. The Mountain Rain programme is underpinned by a strong emphasis on community development, leadership, organisation and education. Lasting outcomes can only be achieved when the beneficiaries themselves commit to work together, look to the interests of others and invest in the future of their communities.

Participatory assessment of needs

Needs assessment has been undertaken by Nuevas Esperanzas in the project area in a number of different forms:

- Preliminary visits
- Informal feedback from pilot projects
- Coordination with the local Mayor’s office
- Participatory Rural Appraisals (PRAs)
- Participation in third party consultations (Protected Area Management Plan)

From February to May 2008 Nuevas Esperanzas undertook a series of PRAs in five of the target communities, Agua Fría, El Ojochal del Listón, El Najo, Mata de Caña and Las Pilas. Around 140 people attended, representing over 70% of the beneficiary families in these communities.

The Participatory Rural Appraisals were carried out according to the following principles:

- The PRAs aimed to achieve what is known as ‘Interactive Participation’, in which the beneficiaries participate in a joint analysis of the problems, designing projects together with the facilitating NGO. The stake of the local community is high because the projects to be implemented were their design.
Women were given opportunities to participate in women-only groups. Culturally, women are not often involved in community decision-making. On one occasion when Nuevas Esperanzas staff arrived at Agua Fría for a PRA workshop, 40 community members were waiting – all of them men! Nuevas Esperanzas now advises communities in advance that women must be well represented in meetings. To ensure that their views are properly considered they work in women-only groups, facilitated by female project staff. Whilst there are always opportunities for discussion between men and women in plenary sessions, the results of women’s working groups are always reported separately from those of men. The communities themselves (both women and men) accept and appreciate this approach.

Techniques applied were based on indirect questioning. Traditionally in Nicaragua, community assessments (diagnósticos) are undertaken using very direct methods based on questionnaires, direct observation and limited problem analysis (almost always with community leaders who are almost always men). The results are rarely checked against other sources of information and are generally treated as unquestioningly correct. Having found that the published results of these assessments are very rarely correct (or at least only present one point of view), Nuevas Esperanzas sought to apply indirect techniques to obtain information and evaluate problems with the communities, always triangulating information. The preferred techniques include mapping exercises, resource assessments and prioritisation exercises.

Consultation was in situ. An error committed by many organisations (as well as by Nuevas Esperanzas in the past) is to hold workshops in locations convenient for the facilitators rather than for the beneficiaries, usually restaurants with facilities for PowerPoint presentations, flips charts and refreshments. Nuevas Esperanzas always undertakes its PRAs within the beneficiary communities themselves, avoiding projectors and flip charts, and instead using simple household objects to make maps on the ground. This approach has produced much more rewarding results, encouraging greater participation of women who are less able to travel and including all members of communities, not just those who are literate and formally educated.

Consultations and participatory workshops were kept to a minimum. Many organisations and local authorities seek to consult communities as part of their work and a significant time commitment is demanded from people who face a daily struggle to feed their families. Expectations and hopes are raised but subsequently dashed when the consultation fails to be followed up by any kind of assistance. Nuevas Esperanzas only asks for potential beneficiaries to give their time where there is a realistic possibility that this process will help the communities themselves or will lead to future assistance.

The methodology applied in each PRA consisted of the following:

- Mapping of each community in single sex groups (usually no larger than ten). Maps were made on the ground using match boxes, seeds, drinking straws, ash, buttons, etc. The participants identified houses, water sources, paths, schools, churches, etc.
- After the participants had included all they were able to think of, facilitators suggested other resources not indicated on their maps and discussed why the participants had not included them.
- Participants were then given a bag of nails. There is a Nicaraguan expression "Los clavos son los clavos", a pun on the word for problem which also means nail. The participants placed the nails on their maps to indicate problems – the more nails, the bigger the problem.
- The participants were encouraged to explain the problems and consider the causes and effects (problem tree analysis). Differences of opinion were noted and facilitators encouraged the participants to debate these issues.
- A bag of seeds representing money (both symbolically and literally to farmers!) was given to participants to allocate to the parts of the community where investment was most needed. Again, differences were investigated.
- Where nails and seeds did not overlap, the reasons for this were investigated. Some 'internal' problems were thus identified which did not need any outside (financial) assistance.
- In a plenary session, the work of different groups was compared and differences investigated. Differences between men and women were drawn out. In general both men and women found it interesting to see the differences although in one case the men tried to change the map made by the women!

The exercises proved to be a very useful method of obtaining information in an indirect way, less subject to bias. All participants enjoyed participating in these exercises and some found the conclusions useful in
themselves in terms of identifying the issues which hold them back. The results were reasonably consistent between communities, although specific local issues particular to each community also came up.

During the PRA in El Ñajo, the issues of most concern to the women were:

- Women’s views are rarely taken into consideration
- Domestic violence is a problem
- Children cannot go to school when it rains
- Women sometimes have to help the men with the farming
- There is no health promotion in the community (and public health programmes such as mosquito control only happen as far as the neighbouring community at the bottom of the hill where they also have to go for vaccinations)
- Older children have to go to Telica to go to secondary school
- All the women are Catholic but no priest ever visits them

The most significant needs according to the women were (in order of priority):

1. Better access (footpaths)
2. Water (specifically rainwater harvesting)
3. Latrines and bathing facilities
4. Assistance with agriculture

For the men, the issues of most concern were:

- The community has a hot spring and volcanic fumaroles and the hot ground adversely affects crops
- There is no access when it rains (so children do not go to school)
- Soil erosion is a problem
- There are very few trees left

The most significant needs according to the men were (in order of priority):

1. Better access (footpaths)
2. Water
3. Assistance with agriculture
4. Latrines

**Improvements to access**

Until 2009, none of the seven communities included in the Mountain Rain project area was accessible by vehicle. All are dispersed communities in remote locations on the slopes of Volcán Telica and Cerro Rota and were accessible only on foot or horseback. The principle reasons for improving access were to facilitate the delivery of materials for construction projects and to improve access to markets and basic services. This component of the Mountain Rain programme also aimed to develop community organisation and leadership so that access routes could be maintained in the long term.

In 2008, Nuevas Esperanzas began work on improving access to two of the seven communities, El Ojochal del Listón and El Caracol. This work consisted of widening paths and infilling areas of significant erosion. Steeply inclined stretches were paved with cobbles and mortar and structures built to divert water. Gabions were also used to protect fords where stream channels unavoidably cross the road. This work was intensive and required consistent and committed community participation. It was not necessarily considered feasible at the outset to open access by vehicle as far as the community of El Ojochal itself, but it soon became obvious that the families in El Ojochal del Listón would not settle for anything less! Early work on what was becoming a road (having been nothing more than a footpath) was driven by the community members themselves and their enthusiasm and initiative influenced the prioritisation and planning of work by Nuevas Esperanzas. Levels of community participation remained high throughout the six months of road building. Farmers from the community of San Jacinto who rent
land on the slopes of Volcán Telica also participated in this work, along with groups of students from the secondary school as part of their community service. On 1st December 2008, the community of El Ojochal del Listón was reached for the first time in more than 30 years by vehicle. Although the road was not complete and not yet ready for a fully laden vehicle, this provided a significant boost to morale. The road was finally completed two months later at the end of January 2009. Following completion of the access road to El Ojochal del Listón, the residents of the higher part of the community began work on a temporary access road to their houses, around 860 metres above sea level.

A report on the road to El Ojochal del Listón in 2009 stated:

“For the people who live in this community, this road represents a lifeline. Materials needed to build rainwater harvesting systems can now be delivered by pickup truck. Farmers can now transport their produce to market with ox and cart, greatly increasing their potential income. In a medical emergency, a patient can be brought down the hill safely, and in case of a volcanic eruption the time to reach the bottom of the hill is now half what it used to be.”

This turned out to be somewhat prophetic as the road has now been used for each of these purposes including several medical emergencies and an evacuation from the eruption of Volcán Telica in May 2011.

Work was also undertaken on improving access to the community of El Caracol, 200 metres above sea level. Although this was not as challenging as the road to El Ojochal del Listón, it was nonetheless a significant achievement for the community.

Rainwater harvesting

Rainwater harvesting is the only viable solution to the water needs of many of the families living within the Maribios volcanoes. The climate of this area is such that plentiful supplies of rainwater can be collected from roofs during the wet season, but the challenge is to store sufficient water to last for the five months of the dry season and to protect this water from contamination. The systems promoted by Nuevas Esperanzas have large, closed, ferrocement tanks designed to let rainwater in but keep mosquitoes out. The technique used to construct these ferrocement tanks is simple and only locally available materials and basic hand tools are needed. The tanks are robust and can last for thirty years or more. Collection of rainwater is sustainable, relatively simple and cost-effective. The photographs on pages 22-23 illustrate the construction process and engineering drawings are also included on pages 27-29.

As of October 2011, 69 rainwater harvesting systems have been constructed with storage capacities ranging from 14 m³ to 71 m³. 27 of these systems have been constructed in the hillside communities which are part of the Mountain Rain programme. In all communities, a pilot tank is first built for communal use. This provides an opportunity to build local capacity and train construction workers in the technique. Quality control is very important in the construction of these systems. In subsequent phases, families build their own systems under the supervision of experienced builders. Communal tanks have so far been built in the communities of El Ñajo, El Caracol and Las Pilas, while in El Ojochal del Listón domestic tanks have been built for all families (either individual or shared). In the case of Agua Fría, two communal and three shared tanks have so far been built.

The outcomes of this project so far include:

- The time spent collecting water was reduced from a maximum of four hours per day to a maximum of 15 minutes per day for families with domestic rainwater harvesting systems. In this context a distance of less than 100 metres to a source is equivalent to a round trip of less than 15 minutes, whilst a distance of 5 kilometres is equivalent to a round trip of 4 hours.
- Water availability during the dry season has increased from an average of 28 litres/person/day (collected from springs) to 35 litres/person/day (from rainwater harvesting). The average amount of water available from rainwater harvesting as an average of the whole year including both wet and dry seasons is 54 litres/person/day.
- Water provided by rainwater harvesting contains 0 E.coli/100 ml (World Health Organisation guideline value) in 52% of samples and <10 E.coli/100 ml (low risk) in 86% of samples. Counts of E.coli bacteria indicate the risk of waterborne disease. This represents a significant improvement
over existing spring sources, none of which tested negative for *E.coli* and three of which (including the most used) contained over 100 *E.coli*/100 ml (high risk).

**Latrines**

Ventilated latrines have so far been built for all of the 26 houses in El Ojochal del Listón, where previously only three had any sort of sanitation. In order to facilitate the construction of these latrines in an area where access is difficult, a new model was specially designed, combining convenient and hygienic moulded fibreglass bases and pedestals with a simple, low cost cubicle made by wrapping sheets of galvanised iron around some wooden posts. This 'wrap around' design gives total privacy without the need for a door which is often the weak point of many low cost latrines. Photographs of the latrines on page 24 illustrate the design and construction process.

**Organic family gardens**

Opportunities for women to contribute to family income are relatively limited in the hillside communities. Income is almost entirely generated from beans which are grown significant distances away from the home, meaning that women have limited opportunities to be involved as their primary responsibility involves work in the house and garden. Traditional family roles, where men are the principal ‘producers’, can lead to a sense of disempowerment amongst women. In November 2009, a project began with the purpose of helping women to have a greater role in providing for their families. The project also aimed to improve the nutrition of these families whilst promoting the use of organic gardening techniques. The project was intended to be a pilot with twenty women from the community participating.

During the seven month project, six family gardens were established. Training sessions were given in organic techniques such as composting and pest control as well as the best way to establish a garden and support plant growth. Tools and seeds for ten different vegetables were distributed to the participants at an early stage to encourage and motivate them as they began work on establishing their gardens. Some were more successful than others with green beans, radishes and peppers producing the best harvest. At the start of the project drip irrigation was introduced but in practice the women found this technique difficult to manage. They were concerned that the crops were not getting enough water, so they decided to irrigate the plants with a watering can.

A second phase of the project began in August 2010, this time with 16 family gardens in El Ojochal del Listón as well as a first garden in El Ñajo, shared between four women. Radish, pepper, tomato, sorghum, carrot, green bean and water melon seeds were provided although training sessions focused primarily on growing tomatoes and peppers, as these were the priority vegetables for the participants.

**Fire prevention and reforestation**

The slopes of Volcán Telica were once covered by dense dry tropical forest, but the clearing of land for agriculture, combined with illegal logging, pests, forest fires and hurricanes, has reduced the forest to small, isolated fragments. Of the various factors contributing to deforestation on Volcán Telica, perhaps the most serious has been indiscriminate burning due to “slash and burn” farming, hunting of iguanas, collection of honey from natural hives, or even just recreation. Forest fires not only destroy large areas of forest, but they also affect the local fauna, already under threat from hunting. Some of the farmers in the hillside communities within the Telica-Rota Protected Area are owners of land which includes natural forests, but they usually regard these areas as “unproductive”; when looking for ways to increase their income, farmers are reluctant to pursue options to generate income from forested land and see clearing the forest as the only viable solution.

In September 2009, Nuevas Esperanzas signed an agreement with the Nicaraguan Environment Agency, MARENA, to co-manage the Telica-Rota Protected Area and in January 2010 began a reforestation and conservation project to address the loss of dry tropical forest in this area. As part of this project it was important to assess the scale of damage caused by forest fires and to understand the reasons behind environmentally damaging practices in the area. Fires are at their most intense in the latter months of the dry season and, from February to May 2010, a total of 19 fires were investigated in the area. The areas
burned were mapped using GPS and the habitats affected were recorded. In addition to the monitoring of fires in the sample area, Nuevas Esperanzas’ team members also assisted the training of local volunteer fire brigades from the communities of El Ojochal, Agua Fría and El Ñajo.

Before the tree planting could begin, mapping of the various ecosystems was needed to determine the most effective areas for reforestation. It was also necessary to map property lines and obtain feedback from land owners regarding potential reforestation sites. Local engagement was essential, especially since local land owners are likely to be the caretakers of any reforested areas. To increase incentives for farmers to give up agricultural land for reforestation, fruit trees such as mangoes and avocados were mixed with other species native to the dry tropical forests of the region. Within four or five years, the fruit trees planted will help farmers to diversify their production and increase their income. A total of 10,790 plants were delivered to the community. Monitoring of survival rates and tree growth is ongoing.

Beekeeping

Beekeeping is an excellent way of establishing sustainable livelihoods in protected areas. Because honey production depends on the availability of pollen from flowering plants and especially trees, there is a direct incentive for beekeepers to preserve existing forests. Furthermore, beekeeping is both a sustainable form of income generation, and an alternative to agricultural activities which have resulted in the destruction of endangered ecosystems. Once the relationship has been established between the abundance of flowering trees and the potential levels of honey production, beekeepers often become committed conservationists, knowing that protection of the environment is also good for business.

Early in 2010, work began on a detailed proposal for a beekeeping project and visits were made to learn from other projects in the Departments of León and Estelí. Meetings were held in the four communities identified as the most appropriate for the pilot scheme to gauge interest. In June a beekeeping specialist was contracted to join the Nuevas Esperanzas team and training sessions for the communities of El Ojochal del Listón and El Ñajo began soon afterwards with the first hives arriving in El Ojochal in July 2010. Participation has varied across the communities but of the 20 participants, eight from the communities of El Ojochal del Listón and El Ñajo have expressed that they would like to work together as a beekeeping group over the long-term. It is these 8 individuals who will be receiving higher level instruction over the next five months.

There have been two honey harvests to date, both in the apiary located in El Ojochal del Listón. In each harvest, honey was taken from two hives, with an average of 11.9 kg (8.3 liters) harvested from each hive, for a total of 47.4 kg (33 liters) between the two harvests. This yield exceeded expectations and indicates a significant potential for honey production in the protected area.

Objectives

General objectives of the Mountain Rain programme

'Mountain Rain’ is a long-term integrated programme which aims to encourage the development of sustainable livelihoods in seven hillside communities in an environmentally sensitive and disaster vulnerable area of western Nicaragua. The target area is located on the western side of Nicaragua in the Department of León. The beneficiary communities are Agua Fría, El Ñajo, El Caracol, El Ojochal del Listón, Mata de Caña, El Cacao, and Las Pilas. The intended outcomes of the Mountain Rain programme are:

1. Improved access to safe water in seven remote hillside communities through rainwater harvesting and protection of spring sources.
2. Improved access to sanitation through construction of latrines and hygiene promotion by women.
3. Improved access to agricultural land through improvements to paths and tracks which allow better access to markets.
4. Diversified land use and farming practices in target area to increase income, improve sustainability and reduce vulnerability to environmental shocks and stresses.
Specific objectives of the present proposal

The present proposal is focused on the smallest of the seven communities, El Ñajo. Whilst some activities are being undertaken in most communities, some currently show a greater potential and higher level of community engagement than others. El Ojochal del Listón is the ‘model’ community where most work has been undertaken; in 2006 this was the first of the hillside communities to build a communal rainwater harvesting system and in 2009 it became the first community in which each family has access to a domestic water supply from rainwater harvesting. As the focus of the programme moves to other communities, El Ñajo is considered to be the best prepared for a significant investment of resources. The community participated well in the construction of a communal rainwater harvesting system in 2009 and women and men from El Ñajo have participated enthusiastically in the family gardens and beekeeping projects respectively. A significant investment in the infrastructure of the community at this time would boost morale and reward the dedication and commitment of the community to work together.

The specific objectives of this project are:

1. Improve access to the community of El Ñajo through the construction of a rough but durable, partially-paved road to give year round access to the community by vehicle (4x4) and ox and cart. This road will facilitate the delivery of materials for this and other projects, as well as assist farmers in transporting their produce to market.
2. Facilitate the long-term management of repairs to the road by providing relevant training (including community organisation).
3. Improve access to water for four families through the construction two 20 m³ and two 30 m³ domestic rainwater harvesting tanks.
4. Improve access to water for two further families* by reducing demand on the existing 40 m³ communal rainwater harvesting tank (this tank will become a shared domestic tank for two families).
5. Provide training in the management and maintenance of rainwater harvesting systems, as well as good hygiene practices.
6. Construct a latrine for each household in the community, involving women as far as possible in the work.

*Note that one family in El Ñajo already has their own reservoir which was not constructed as part of the Mountain rain programme. They will not participate in the rainwater harvesting component but have indicated their willingness to assist with the road.

Indicators of project success will be:

1. Access by vehicle to the community in all conditions (except during extreme storms or immediately after hurricanes when fallen trees often block mountain roads).
2. Road is maintained by the community under their own initiative.
3. Access to water from rainwater harvesting within 50 m for all families in El Ñajo (reduced from a maximum of 750 metres to the existing spring)
4. Water contains fewer than 10 E.coli per 100 ml in all rainwater tanks (reduced from baseline of 19 E.coli/100 ml from the spring)*
5. All families have access to adequate sanitation and latrines used by men, women and children.
6. Good hygiene practices are followed and tanks are maintained by families under their own initiative.

*baseline to be confirmed.

Project methodology

Improvements to access: the road to El Ñajo

The 3 km route to be improved has been surveyed using GPS and is shown in the profile from Google Earth on page 26. The route starts in the neighbouring community of Las Quemadas (where some repairs will be necessary) and follows a field boundary from the highest house in Las Quemadas towards
the east from around 700 metres. This section will require some widening and infilling and at one point will require gabions to prevent erosion where it crosses a small ephemeral stream. Gabions act as highly effective and environmentally sensitive retaining walls which permit the water to pass through without causing erosion. Their construction is simple. Cages of woven galvanised wire mesh with a volume of one cubic metre are built with rebar along the edges to provide rigidity. The cages are filled with rocks and built up to form a retaining wall. Over time, the gabions become overgrown and barely visible. They will last for decades even with strong currents flowing over them.

The steepest section, from 200 metres to around 300 metres above sea level, runs southwards up the side of the mountain for around 800 metres. The average gradient of this section is around 12% and reaches a maximum of 17% at any one point. This section is badly eroded and, since the soil is very clayey, much of it will require paving with cobbles and a cement mortar. The technique used for the construction of the road to El Ojochal del Listón is shown in the photographs on pages 20-21. The section will use a similar technique. From the experience of the road to El Ojochal, it is known that one bag of cement is needed for each linear metre of road. Around half of this section will need to be paved so the budget for this project is based on 400 bags of cement. Also included in the budget is a cement mixer. Whilst mortar is mixed by hand for smaller projects such as the rainwater tanks, the road construction will be greatly facilitated by the use of a small (1 bag) mixer. After completion of this project, the mixer will be used by Nuevas Esperanzas for other projects to improve access. Where necessary, structures will be built to divert water from the road into ditches.

The final section from the spring in El Ñajo to the houses in the centre of the community will require some shorter paved ramps. This section mostly passes through trees and therefore erosion is much less severe. The highest part passes close to some active volcanic fumaroles, so care will need to be taken in this area to ensure that the route avoids any areas of instability or hot ground.

Crucial to the success of this component of the project is community participation. The community is small and although volunteers will work in rotation, they will need to dedicate more than the one day per week which was the contribution of community members when the road to El Ojochal was built. Levels of motivation are high, however, and there is every indication that community participation will be good. The movement of materials will be overseen by Nuevas Esperanzas’ logistician. Community organisation will be facilitated by the Community Coordinator and the technical aspects of the work will be managed by the supervising Civil Engineer. A building supervisor will be on site throughout construction.

Rainwater harvesting

The project will follow a carefully designed methodology which Nuevas Esperanzas has implemented in other communities and in the construction of a pilot rainwater harvesting system in El Ñajo in 2009. This provided an opportunity to build local capacity and train workers in the technique. Quality control is very important in the construction of these systems and the work of building the family tanks will be supervised by experienced builders. Each beneficiary family must provide two people for up to six weeks to build the tanks. There is such demand in this community that participation is most unlikely to present a significant problem.

It is proposed that four rainwater harvesting systems be constructed in El Ñajo to ensure that all families have access to water within 50 metres of their home. The existing communal tank will become a shared tank for two families. This means that all families will have access to at least 20 m³ of water for the duration of the dry season, providing around 130 litres of water per family per day. The larger families will have slightly larger rainwater tanks.

The construction method will be based on Nuevas Esperanzas’ tried and tested ferrocement design. After laying the reinforced concrete base, a free standing frame of welded mesh is erected and pulled into shape. This consists of the rigid welded mesh wrapped in chicken wire and tensioned with rings of 16 gauge wire. The frame of reinforcing steel is then wrapped in sacking. This sacking allows the walls to be built without the need for wooden formwork. The walls are rendered first from the inside of the tank using a cement mortar to cover the reinforcement. When the rendering on the inside is complete, the sacking is removed from the outside. The outside of the tank is rendered until the wall has a thickness of 6 cm. With the walls complete, a fine mortar finish is applied to the inside of the walls and the base of the tank to reduce infiltration of water. The domed roof is built in the same way as the walls over a temporary
wooden structure which will be made from branches. The wooden formwork is left inside the tank for a minimum of eight days. The photographs on pages 22-23 show the different steps of the construction process.

One of the great advantages of rainwater harvesting is that operation and maintenance is relatively simple. Very few repairs are ever needed and these can almost always be done without the need for external input. Since these systems will be individually owned and managed by the beneficiary families themselves, water committees are unlikely to be an effective means for providing maintenance and there is no need to collect tariffs from users. All beneficiaries will be trained in the management of their systems and spares (valves, tubes, adaptors) can be easily procured from suppliers in León. As with previous projects already implemented, this project will empower local families to manage their own water supply, providing training in the collection and storage of water and the rationing of its use. Individual household systems have very high rates of success in terms of sustainable management in the long-term.

**Latrines**

The latrines will follow a design similar to that used in El Ojochal del Listón. The majority of the work required is in the excavation of a pit 3 metres deep. It is important to ensure that pits are not dug too wide as the dimensions of the fibreglass slab are relatively narrow. A template will be provided to each family to ensure the pit is dug correctly. The civil engineer will check the ground conditions in each pit to ensure that they are adequately lined. In most cases, two courses of cement blocks near the surface are likely to be sufficient to ensure stability. The fibreglass slabs with moulded pedestals to be used are shown in the photographs on page 24 together with the ‘wrap around’ superstructure.

As far as possible, the latrine project will be implemented through women. In the PRAs, women consistently ranked sanitation amongst the highest priorities, whilst in most communities, men did not consider it important at all. Although El Najo was something of an exception (the men ranked latrines as the fourth most important need), it is likely that women’s motivation to improve sanitation will be considerably higher. Nuevas Esperanzas’ coordinator for women will involve the women from the community in the planning and design of the project and, as far as possible, in its implementation.

The sanitation project will be complemented by a workshop to provide training in the management of the rainwater harvesting tanks and promote good hygiene practices. This will be targeted primarily at the women as the principle water users and because, as the old adage says, ‘if you educate a man, you educate an individual; if educate a woman, you educate a family’.

**Monitoring, evaluation and project management**

During the construction phase of the project, physical progress on construction will be monitored against previously established Gantt charts and spending profiles using the ‘earned value’ method. Community workers will provide feedback on levels of participation and community organisation. Once the rainwater harvesting systems are complete and in operation, a participatory evaluation of the project will be undertaken to determine the extent to which access to water has been improved. To improve understanding of the ‘water balance’ of the tanks, beneficiaries will record the level of water each month for the first year of operation. Monitoring of water quality will be undertaken by Nuevas Esperanzas. This information will be used to identify specific problems and training needs as well as to contribute to a continual process of refinement of the design of the tanks.

The project will also be managed according to a new project management structure introduced by Nuevas Esperanzas to train and empower national staff at the same time as providing quality assurance. The project will be managed by Ing. Arturo Juárez, a Nicaraguan Civil Engineer with nearly ten years of experience in the supervision of construction projects. A new role of Project Reviewer will be introduced to provide support and to peer review project progress. The Project Reviewer will independently monitor the progress of the project, not only in terms of the physical advancement but also through regular evaluations of community participation and stakeholder perception. Both the Project Manager and the Project Reviewer will report on progress to the Director on a monthly basis. The Project Reviewer will provide feedback on the project to the Project Manager as well as any coaching necessary on the use of
project management tools such as logical frameworks and earned value tracking. Financial statements and project progress reports will be produced on a monthly basis.

Brief profiles of the key project management staff are given below:

Arturo Juárez (Nicaragua) will be Nuevas Esperanzas’ Project Manager. Arturo is a chartered civil engineer with experience in construction and also a chartered surveyor. He has additional training in community participation and project management. Arturo has worked in construction since 2002 and acted as supervising engineer for the construction of 112 low-cost houses as part of the La Palmerita resettlement project in 2006/2007. He has been responsible for the construction of rainwater harvesting systems supervising seven distinct projects which included the construction of large ferrocement tanks. Arturo also has experience in the design of water projects and the installation of drainage systems and in 2007 assisted with an emergency relief operation after Hurricane Felix, building raised latrines, protecting a spring and rehabilitating contaminated wells.

Luke Pekrul (USA) is the Programme Manager for Nuevas Esperanzas UK and will act as Project Reviewer. His responsibilities include the management of environmental and social programmes, monitoring and evaluation, programme development and coordination of a multidisciplinary team of national and international staff. Luke has a degree in Spanish and International Development from Clark University and a Masters in International Development and Social Change from the same institution. Prior to joining Nuevas Esperanzas in 2009, he spent three years as Director of Programs for a Latino multi-services agency in Worcester, Massachusetts. Luke’s experience includes development work in Zambia, the Dominican Republic and Nicaragua as well as support for immigrants in the United States.

Andrew Longley (UK) is the Director of Nuevas Esperanzas UK. Andrew is an experienced programme manager and has a PhD in Geology, a Masters degree in Groundwater Engineering and further training in technical and managerial aspects of relief and development work. Previously he managed a wide range of water and environmental projects for the UK Environment Agency and consulting engineers WS Atkins, and has worked on water-related development projects in Nicaragua, India and the Democratic Republic of Congo. His technical experience includes water supply, sanitation, environmental management and design and implementation of training programmes. Andrew was the Country Director for Mercy Ships in Nicaragua and managed programmes which included water, health, agriculture, the environment and housing before founding Nuevas Esperanzas in 2005.
Project budget

The budget is presented below split by project component. Material and equipment costs are based on recent quotations or previous purchases. Transport costs are based on the use of a Toyota Land Cruiser 4x4 pickup truck; vehicle use is logged and charged to each project by the kilometre. The rate calculated is sufficient to cover fuel, tyres (a very significant cost in difficult terrain), maintenance, insurance and depreciation. Staff costs are based on hourly or daily rates which reflect the full costs of employing each member of staff including salaries, social security, holidays, statutory bonuses and accrued liability for redundancy payments. Indirect project costs cover office costs including rent, utilities, telephones, computers and stationery as well as support staff not billed directly to the project (bookkeeping, housekeeping, etc). Project management costs are listed separately after each project component.

Road

<table>
<thead>
<tr>
<th>Equipment</th>
<th>1 bag cement mixer with 8 HP Briggs Stratton engine</th>
<th>$ 1,897.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>Cement (42.5 kg bags) 400 bags $ 8.67 each $ 3,466.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gabions (1 m$^3$, woven mesh) 6 gabions $ 20.09 each $ 120.53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$ 3,587.20</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>Use of vehicle for 25 days @ 140 km per day 4250 km $ 0.45 /km $ 1,912.50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$ 1,912.50</td>
<td></td>
</tr>
<tr>
<td>Staff costs</td>
<td>Building supervisor 40 days $ 21.97 /day $ 878.60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Civil Engineer 80 hours $ 7.32 /hour $ 585.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Logistician 200 hours $ 5.88 /hour $ 1,176.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Community Coordinator 120 hours $ 5.88 /hour $ 706.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Administrator 16 hours $ 9.90 /hour $ 158.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subsistence (building supervisor) 40 days $ 5.78 /day $ 231.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$ 3,736.55</td>
<td></td>
</tr>
<tr>
<td>Indirect project costs</td>
<td>Includes rent, utilities, support staff, etc @15% $ 1,670.06</td>
<td></td>
</tr>
<tr>
<td>TOTAL for road</td>
<td>$ 12,803.82</td>
<td></td>
</tr>
</tbody>
</table>

30 m$^3$ rainwater harvesting tanks

| Materials | Cement (42.5 kg bags) 58 bags $ 8.67 each $ 502.67 |
|           | Welded mesh (6 m x 2.4 m x 6.2 mm) 6 sheets $ 75.55 each $ 453.30 |
|           | PVC gutters, tubes and fittings | $ 231.46 |
|           | Other construction materials | $ 273.93 |
|           | $ 1,461.36 |
| Transport | Transport of materials (from León) 500 km $ 0.45 /km $ 225.00 |
|           | Haulage of sand (from river bed) 150 km $ 0.45 /km $ 67.50 |
|           | Supervision visits 150 km $ 0.45 /km $ 67.50 |
|           | $ 360.00 |
| Staff costs | Building supervisor 30 days $ 21.97 /day $ 658.95 |
|             | Civil Engineer 15 hours $ 7.32 /hour $ 109.83 |
|             | Logistician 50 hours $ 5.88 /hour $ 294.17 |
|             | Community Coordinator 10 hours $ 5.88 /hour $ 58.83 |
|             | Administrator 4 hours $ 9.90 /hour $ 39.60 |
|             | Subsistence (building supervisor) 30 days $ 5.78 /day $ 173.33 |
|             | $ 1,334.72 |
| Indirect project costs | Includes rent, utilities, support staff, etc @15% $ 473.41 |
| TOTAL for 30 m$^3$ tanks | 2 tanks | $ 3,629.48 $ 7,258.97 |
# 20 m³ rainwater harvesting tanks

**Materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (42.5 kg bags)</td>
<td>45 bags</td>
<td>$8.67 each</td>
<td>$390.00</td>
</tr>
<tr>
<td>Welded mesh (6 m x 2.4 m x 6.2 mm)</td>
<td>4 sheets</td>
<td>$75.55 each</td>
<td>$302.20</td>
</tr>
<tr>
<td>PVC gutters, tubes and fittings</td>
<td></td>
<td></td>
<td>$170.91</td>
</tr>
<tr>
<td>Other construction materials</td>
<td></td>
<td></td>
<td>$215.16</td>
</tr>
</tbody>
</table>

**Transport**

<table>
<thead>
<tr>
<th>Description</th>
<th>Distance</th>
<th>Rate /km</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport of materials (from León)</td>
<td>400 km</td>
<td>$0.45 /km</td>
<td>$180.00</td>
</tr>
<tr>
<td>Haulage of sand (from river bed)</td>
<td>100 km</td>
<td>$0.45 /km</td>
<td>$45.00</td>
</tr>
<tr>
<td>Supervision visits</td>
<td>150 km</td>
<td>$0.45 /km</td>
<td>$67.50</td>
</tr>
</tbody>
</table>

**Staff costs**

<table>
<thead>
<tr>
<th>Position</th>
<th>Duration</th>
<th>Rate</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building supervisor</td>
<td>30 days</td>
<td>$21.97 /day</td>
<td>$658.95</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>15 hours</td>
<td>$7.32 /hour</td>
<td>$109.83</td>
</tr>
<tr>
<td>Logistician</td>
<td>30 hours</td>
<td>$5.88 /hour</td>
<td>$176.50</td>
</tr>
<tr>
<td>Community Coordinator</td>
<td>10 hours</td>
<td>$5.88 /hour</td>
<td>$58.83</td>
</tr>
<tr>
<td>Administrator</td>
<td>4 hours</td>
<td>$9.90 /hour</td>
<td>$39.60</td>
</tr>
<tr>
<td>Subsistence (building supervisor)</td>
<td>30 days</td>
<td>$5.78 /day</td>
<td>$173.33</td>
</tr>
</tbody>
</table>

**Indirect project costs**

Includes rent, utilities, support staff, etc @15%

**TOTAL for 20 m³ tanks**

2 tanks

$ 2,975.99  $ 5,951.98

---

# Latrines

**Materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moulded fibreglass latrine slab</td>
<td>7 latrines</td>
<td>$63.70 each</td>
<td>$445.90</td>
</tr>
<tr>
<td>Other materials (cement, blocks, GI sheets, etc)</td>
<td>7 latrines</td>
<td>$57.91 each</td>
<td>$405.36</td>
</tr>
</tbody>
</table>

**Transport**

<table>
<thead>
<tr>
<th>Description</th>
<th>Distance</th>
<th>Rate /km</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport of materials and supervision visits</td>
<td>300 km</td>
<td>$0.45 /km</td>
<td>$135.00</td>
</tr>
</tbody>
</table>

**Staff costs**

<table>
<thead>
<tr>
<th>Position</th>
<th>Duration</th>
<th>Rate</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building supervisor</td>
<td>7 days</td>
<td>$21.97 /day</td>
<td>$153.76</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>10 hours</td>
<td>$7.32 /hour</td>
<td>$73.22</td>
</tr>
<tr>
<td>Logistician</td>
<td>20 hours</td>
<td>$5.88 /hour</td>
<td>$117.67</td>
</tr>
<tr>
<td>Coordinator for women</td>
<td>20 hours</td>
<td>$5.49 /hour</td>
<td>$109.83</td>
</tr>
<tr>
<td>Administrator</td>
<td>4 hours</td>
<td>$9.90 /hour</td>
<td>$39.60</td>
</tr>
<tr>
<td>Subsistence (building supervisor)</td>
<td>7 days</td>
<td>$5.78 /day</td>
<td>$40.44</td>
</tr>
</tbody>
</table>

**Indirect project costs**

Includes rent, utilities, support staff, etc @15%

**TOTAL for latrines**

$ 1,748.88

---

# Project Management

**Per month**

<table>
<thead>
<tr>
<th>Position</th>
<th>Duration</th>
<th>Rate</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>20 hours</td>
<td>$7.32 /hour</td>
<td>$146.43</td>
</tr>
<tr>
<td>Project Reviewer</td>
<td>16 hours</td>
<td>$11.82 /hour</td>
<td>$189.12</td>
</tr>
<tr>
<td>Director</td>
<td>8 hours</td>
<td>$17.48 /hour</td>
<td>$139.81</td>
</tr>
</tbody>
</table>

$ 475.36

**Indirect project costs**

Includes rent, utilities, support staff, etc @15%

**TOTAL for project management**

6 months

$ 546.66  $ 3,279.98

**TOTAL PROJECT COST (WITH ALL COMPONENTS):**

$31,043.63
Project funding options

Opportunities for partial funding of the project exist. Note that the budget for the rainwater harvesting tanks is based on the assumption that access by vehicle will be possible for transport of materials. For this reason, these budgets only apply if the road is also included in the project. Note also that the project management costs depend more on the overall duration than on the amount of work. There is significant potential for economies of scale where different project components are combined in the same community.

As a guideline, the following project options are offered, reflecting different combinations of project components:

<table>
<thead>
<tr>
<th>Combinations of project components</th>
<th>Duration</th>
<th>Component cost</th>
<th>Project Management</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road only</td>
<td>3 months</td>
<td>$12,804</td>
<td>$1,640</td>
<td>$14,444</td>
</tr>
<tr>
<td>Road and latrines</td>
<td>4 months</td>
<td>$14,553</td>
<td>$2,187</td>
<td>$16,739</td>
</tr>
<tr>
<td>Road and one rainwater harvesting tank</td>
<td>5 months</td>
<td>$16,433</td>
<td>$2,733</td>
<td>$19,167</td>
</tr>
<tr>
<td>Road and two rainwater harvesting tanks</td>
<td>5 months</td>
<td>$19,409</td>
<td>$2,733</td>
<td>$22,143</td>
</tr>
<tr>
<td>Road, two rainwater harvesting tanks and latrines</td>
<td>5 months</td>
<td>$21,158</td>
<td>$2,733</td>
<td>$23,891</td>
</tr>
<tr>
<td>Road, three rainwater harvesting tanks and latrines</td>
<td>6 months</td>
<td>$24,134</td>
<td>$3,280</td>
<td>$27,414</td>
</tr>
<tr>
<td>Full project</td>
<td>6 months</td>
<td>$27,764</td>
<td>$3,280</td>
<td>$31,044</td>
</tr>
</tbody>
</table>

It should also be noted that opportunities for co-funding exist. A proposal has been prepared for the Georg Fischer Clean Water Foundation for the construction of 20 more rainwater harvesting systems in up to five communities in the Telica-Rota Protected Area. It is possible that this could fund any rainwater harvesting systems in El Najo not funded through the current proposal. It should be noted, however, that since the Georg Fischer Clean Water Foundation is dedicated to water projects, the construction of the road cannot be included in the proposal to this foundation. For this reason, it is proposed that the road be considered the highest priority for funding.
Fig. 1 The community of El Ñajo is located on the northeastern slopes of Volcán Telica, between 300 and 450 metres above sea level, within the Telica-Rota Protected Area. It is located around 4 km from the active crater of the volcano. With a population of 43, it is the smallest community in the protected area.

Fig. 2 This well in El Ñajo taps into a hot spring. This water has a temperature of over 50°C. Water is drawn by a bucket and rope, as shown, and was found to contain 19 E.coli /100 ml. This is the only existing source of water in the community of El Ñajo. This well dries up in the dry season in some years.

Fig. 3 Access to El Ñajo is by means of a 3 km track from the community of Las Quemadas at the foot of the volcano. Farmers from El Ñajo take their produce down to Las Quemadas from where they take public transport to get to markets in nearby towns. This route down the mountain is badly eroded and only passable on foot or horseback. **It is proposed that this track be improved to allow year round access by vehicle.**
In 2009, Nuevas Esperanzas built one rainwater harvesting system at a house in El Ñajo. This 40,000 litre tank was built as a communal water supply to be shared between the seven houses in the community. As such it was a first step towards improving the water supply for the community, but not the final solution.

This house, which belongs to Lucas Tercero González, has a roof area of over 100 m² which makes it ideal for rainwater collection. Eight adults and one child share this house. It is proposed that a 30,000 litre tank be built here.

This house belongs to Cruz Alejandro Torres Herrera. It has a roof area of around 75 m² and is home to a family of five. It is proposed that a 20,000 litre tank be built here.
Fig. 7  This house belongs to Juan Rafael Leyton Poveda. It has a roof area of around 100 m² and is home to three adults and four children. **It is proposed that a 30,000 litre tank be built here.**

Fig. 8  This house belongs to Abraham Tercero Navarette. It is the highest house in the community at 430 metres above sea level and is home to a family of six. **It is proposed that a 20,000 litre tank be built here.**

Fig. 9  Seven young farmers from El Ñajo are training as beekeepers through the project which Nuevas Esperanzas launched in 2010. There are now five hives in El Ñajo and these beekeepers are among the first looking to develop the commercial potential of this enterprise. In addition to the beekeeping project, further assistance in agriculture is being provided through an organic gardening project in which four women from El Ñajo are participating.
Fig. 10 The road to El Ojochal del Listón during construction. A similar technique will be used for the critical section from 200 m to 300 m above sea level on the road to El Ñajo. After levelling the road, cobbles are carefully arranged to provide a firm base.

Fig. 11 The cobbles are then ‘pointed’ with a cement mortar providing a surface which is resistant to erosion and which aids traction, even in wet conditions. This process requires approximately one bag of cement (42.5 kg) per linear metre of road. Depending on conditions and on the availability of manual labour, it is usually possible to construct around 10 metres of road per day.

Fig. 12 A cement mixer, similar to this one which was loaned to Nuevas Esperanzas for the construction of the road to El Ojochal, has been included in the budget for this project. Whilst mortar is mixed by hand for smaller projects such as the rainwater tanks, the road construction will use around 400 bags of cement. After completion of this project, the mixer will be used by Nuevas Esperanzas for other projects to improve access.
Fig. 13  All the manual labour for road improvements will be provided voluntarily by community members working in rotation. Work will be overseen by Nuevas Esperanzas’ building supervisors under the direction of its Civil Engineer.

Fig. 14  One part of the road to El Ñajo which is subject to severe erosion will be protected with gabions similar to this one on the road to El Ojochal. These gabions act as highly effective and environmentally sensitive retaining walls which permit the water to pass through without causing erosion.

Fig. 15  The construction of the gabions is simple. Cages of woven galvanised wire mesh with a volume of one cubic metre are built with ¼” rebar along the edges to provide rigidity. The cages are then filled with rocks and stacked as necessary to form a retaining wall. Over time these gabions become overgrown and barely visible. They will last for decades even with strong currents flowing over them.
The rainwater harvesting tanks will be built according to the tried and tested design which Nuevas Esperanzas has developed over the last six years. After laying the reinforced concrete base, a free standing frame of welded mesh is erected and pulled into shape. This consists of the rigid welded mesh wrapped in chicken wire and tensioned with rings of 16 gauge wire. The frame of reinforcing steel is then wrapped in sacking. This sacking allows the walls to be built without the need for wooden formwork.

The walls are built up from the base of the tank using a cement mortar to cover the reinforcement. It is important to ensure that the mortar has the correct texture and consistency and that it is not contaminated by soil if leaks are to be avoided. Once this first coat is dry, a technique is used to ‘throw’ additional layers to build up the wall to its required thickness. This technique involves a flick of the wrist which takes practice to perfect!

When the rendering on the inside is complete, the sacking is removed from the outside. This sacking can be reused for the construction of the next tank. Excess mortar from the outer surface is then chipped with a small blunt axe. The outside of the tank is rendered until the wall has a thickness of 6 cm. With the walls complete, a fine mortar finish is applied to the inside of the walls and the base of the tank to reduce infiltration of water.
Fig. 19  The domed roof is built in the same way as the walls over a temporary wooden structure. This can be made from rustic local timber (branches, etc). Mortar is applied to the top of the roof leaving a space for the access hatch and for the inflow from the guttering. The wooden structure is left inside the tank for at least 8 days.

Fig. 20 High capacity guttering is used for all roofs to ensure maximum yield. While some joints are glued, others are left loose so that tubes, vulnerable to distortion in sunlight, can be dismantled at the end of each wet season and stored until required again.

Fig. 21  As far as possible, the tap station is integrated into the design of each family’s garden. The main valve used is a robust, non-leaking, self-closing tap.
Fig. 22 The latrines proposed for El Ñajo are similar to those constructed by Nuevas Esperanzas in El Ojochal in 2009. They require an excavation 3 metres deep which is lined with cement blocks near the surface to ensure stability. The design of the lining will be specified by the supervising engineer during excavation as this depends on ground conditions.

Fig. 23 A lightweight moulded fibreglass latrine slab with built-in pedestal is used as a cost effective and hygienic solution for areas where transport of heavy materials is a challenge. This latrine slab is designed to be used with a ventilation pipe which helps reduce odours. The lid helps to prevent vectors such as flies and mosquitoes.

Fig. 24 The latrine superstructure is rustic and uses local materials (rough cut timber) rather than the prefabricated kit which is sold with the fibreglass slab. The purchased materials consist of sheets of galvanised iron which can be easily transported to even the most remote locations. The ‘spiral’ design provides privacy without the need for a door, usually the weakest part of other low cost designs.
Proposed 20,000 litre tank
Abraham Tercero Navarette
6 people

Proposed 30,000 litre tank
Juan Rafael Leyton Poveda
7 people

Existing 40,000 litre tank will be shared between two houses once new tanks are built

Proposed 30,000 litre tank
Lucas Tercero González
9 people

Proposed 30,000 litre tank
Cruz Alejandro Torres Herrera
5 people
Existing rainwater harvesting tank

Proposed rainwater harvesting tank

Access route to be improved

Critical section requiring cemented ramps

Existing road (year round access)
Ferrocement Rainwater Harvesting Tank – 20 m³

Drawing 1: General scheme of tank and tap station with dimensions for typical domestic tank of 20,000 litre capacity.

NOT TO SCALE

Drawn by: Ing. Arturo Juárez November 2009
Ferrocement Rainwater Harvesting Tank – 20 m³

Drawing 2: Detail of construction of tank base showing ground preparation, reinforced concrete base and central column.
NOT TO SCALE

Drawn by: Ing. Arturo Jodra November 2009

1. The wrapping is finished with a wire spacing of 15 cm, until the final 4 wraps which again have a wire spacing of 10 cm.

2. The following 60 cm are wrapped with a wire spacing of 8 cm (11 wraps).

3. The following 60 cm are wrapped with a wire spacing of 5 cm (12 wraps).

4. The wrapping is finished with a wire spacing of 15 cm, until the final 4 wraps which again have a wire spacing of 10 cm.

Drawing 3: Detail of construction of tank wall showing spacing of pre-stressed 15 gauge galvanized wire.
NOT TO SCALE

Drawn by: Ing. Arturo Jodra November 2009

The joints between both the floor and body of the tank, and the roof and body of the tank should be reinforced with perenderal # 2 "L" shaped anchor bars. These anchor bars should measure 60 cm with a spacing of 30 cm. The bonding wire should be pre-stressed and tied to the structure.